International Standard

ISO 19694-7

First edition
2024-02

# Stationary source emissions — Determination of greenhouse gas emissions in energy-intensive industries —

## Part 7: Semiconductor and display industries

*Émissions de sources fixes — Détermination des émissions de gaz à effet de serre dans les industries énergo-intensives —*

*Partie 7: Industries des semi-conducteurs et des écrans*

Reference number
ISO 19694-7:2024(en)

© ISO 2024



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2024
All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

# Contents

Page

**Foreword** ..... **v**
**Introduction** ..... **vi**
**1 Scope** ..... **1**
**2 Normative references** ..... **1**
**3 Terms and definitions** ..... **2**
**4 Abbreviated terms** ..... **6**
**5 Determination of GHG emissions principles** ..... **7**
5.1 General ..... 7
5.2 Major GHG emissions in semiconductor and display ..... 7
5.3 Determination based on mass balance ..... 7
5.4 Determination based on stack emission measurements ..... 8
**6 Inventory boundaries** ..... **8**
6.1 General ..... 8
6.2 Organizational boundaries ..... 8
6.3 Reporting boundaries ..... 9
**7 Direct GHG emissions and their determination** ..... **9**
7.1 General ..... 9
7.2 Direct GHG emissions from combustion and transportation ..... 10
7.3 Direct GHG emissions from process emissions ..... 10
7.3.1 General ..... 10
7.3.2 Tier 1 ..... 13
7.3.3 Tier 2a ..... 14
7.3.4 Tier 2b ..... 15
7.3.5 Tier 2c ..... 15
7.3.6 Tier 3a — Measured process-specific parameters ..... 19
7.3.7 Tier 3b — Stack testing ..... 19
7.3.8 Fluorinated liquids ..... 22
**8 Indirect emissions from imported energy and their determination** ..... **23**
8.1 General ..... 23
8.2 GHG emissions from imported electricity ..... 23
8.3 GHG emissions from external fossil and alternative fuels production and processing ..... 24
**9 General requirements for identifying, calculating and reporting of GHG emissions** ..... **24**
**10 Baselines, acquisitions and disinvestments** ..... **25**
**11 Reporting and performance assessment** ..... **25**
11.1 General ..... 25
11.2 Corporate environmental reporting ..... 26
11.3 Reporting periods ..... 26
11.4 Performance assessment ..... 26
**12 Uncertainty of GHG inventories** ..... **27**
12.1 General ..... 27
12.2 Assessment of uncertainty of the mass balance based method ..... 28
12.2.1 Major sources of uncertainty ..... 28
12.2.2 Uncertainty of activity data ..... 28
12.2.3 Aggregated uncertainties of activity data ..... 29
12.2.4 Application of default values instead of analytical results ..... 30
12.2.5 Evaluation of the overall uncertainty of a GHG inventory ..... 30
12.3 Assessment of the uncertainty for the stack-measurement method ..... 30
**Annex A** (informative) **Content of the monitoring plan** ..... **31**
**Annex B** (informative) **Default emission factors** ..... **32**

© ISO 2024 – All rights reserved

**Bibliography** ..... **40**

© ISO 2024 – All rights reserved

# Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 146, *Air quality*, Subcommittee SC 1, *Stationary source emissions*.

A list of all parts in the ISO 19694 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

© ISO 2024 – All rights reserved

# Introduction

## 0.1 General

This document for the semiconductor and display industry is based on *2019 Refinement to the 2006 IPCC Guideline for National Greenhouse Gas Inventories*.

This document, which deals with specific requirements for the semiconductor and display industry, has been harmonized with ISO 14064-1 and ISO 19694-1, which deal with broader requirements. ISO 19694-1 and this document provide a harmonized method for:

— measuring, testing and quantifying methods for greenhouse gas (GHG) emissions;

— assessing the level of GHG emissions performance of production processes over time, at production sites; and

— establishing and providing reliable, accurate and quality information for reporting and verification purposes.

## 0.2 Overview of semiconductor and display manufacturing process

Semiconductor and display manufacture include processes, such as TFD or plasma EWC of silicon-containing materials, that result in significant carbon dioxide emissions. These emissions are the results of the FC gases and nitrous oxide used in the manufacturing process. Other GHG emissions in semiconductor and display industry include the $CO_2$ and $CH_4$ from direct emissions of combustion, transportation, manufacturing process or indirect emissions (e.g. room heating, on-site transports, on-site power generation, external power production and external transports).

FC gases are used in two important steps of electronics manufacturing:

a) plasma EWC of silicon-containing materials, and

b) cleaning of the chamber walls of TFD and diffusion tools after processing substrates.

The semiconductor and display industry use $N_2O$ as an input gas in TFD processes, and in other manufacturing processes that use $N_2O$, such as diffusion and dry removal of photoresist.

The process emission of FC gases and $N_2O$ should be estimated using the *2019 Refinement to the 2006 IPCC Guideline for National Greenhouse Gas Inventories*. In this document, references are made to the relevant parts of *2019 Refinement to the 2006 IPCC Guideline for National Greenhouse Gas Inventories* depending on the element used for appropriate guidance that includes formulae, tables, etc. However, the *2019 Refinement to the 2006 IPCC Guideline for National Greenhouse Gas Inventories* can be corrected if some errors are detected. Therefore, companies are strongly encouraged to keep referring to Reference [4] and to replace the Annex B with the latest corrected version of Chapter 6, Volume 3 of the *2019 Refinement to the 2006 IPCC Guideline for National Greenhouse Gas Inventories* when it is made available.

© ISO 2024 – All rights reserved

# Stationary source emissions — Determination of greenhouse gas emissions in energy-intensive industries —

# Part 7: Semiconductor and display industries

## 1 Scope

This document provides a methodology for calculating greenhouse gas (GHG) emissions from the semiconductor and display industry. This document includes the manufacture of semiconductor devices, microelectromechanical systems (MEMS), photovoltaic (PV) devices and displays. This document allows to report GHG emissions for various purposes and on different bases, such as a per-plant basis, per-company basis (by country or by region) or an international group basis. This document addresses all of the following direct and indirect sources of GHG:

— direct GHG emissions [as defined in ISO 14064-1:2018, 5.2.4 a)] from sources that are owned or controlled by the company, such as emissions resulting from the following sources:

  — process: fluorinated compound (FC) gases and nitrous oxide ($N_2O$) used in etching and wafer cleaning (EWC), remote plasma cleaning (RPC), in situ plasma cleansing (IPC), in situ thermal cleaning (ITC), $N_2O$ thin film deposition (TFD), and other $N_2O$ using process;

  — fuel combustion related to equipment and on-site vehicles, room heating/cooling;

  — fuel combustion of fuels for on-site power generation;

— indirect GHG emissions [as defined in ISO 14064-1:2018, 5.2.4 b)] from the generation of imported electricity, heat or steam consumed by the organization.

Other indirect GHG emissions [as defined in ISO 14064-1:2018, 5.2.4 c) to f)], which are the consequence of an organization's activities, but arise from GHG sources that are owned or controlled by other organizations, are excluded from this document.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement — Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)*

ISO 19694-1:2021, *Stationary source emissions — Determination of greenhouse gas emissions in energy-intensive industries — Part 1: General aspects*

ISO 14064-1:2018, *Greenhouse gases — Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals*

Calvo Buendia, E., Tanabe, K., Kranjc, A., Baasansuren, J., Fukuda, M., Ngarize, S., Osako, A., Pyrozhenko, Y., Shermanau, P. and Federici, S. 2019 Refinement to the 2006 IPCC Guideline for National Greenhouse Gas Inventories *(2019 Refinement*), Volume 3, Chapter 6 Electronics. URL: https://www.ipcc-nggip.iges.or.jp/public/2019rf/index.html

© ISO 2024 – All rights reserved